ANALYSIS OF RFI STATISTICS FOR AQUARIUS RFI DETECTION AND MITIGATION IMPROVEMENTS

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ABSTRACT

Aquarius is an L-band active/passive sensor designed to globally map sea surface salinity from space [1, 2]. Two instruments, a radar scatterometer and a radiometer, observe the same surface footprint almost simultaneously. The radiometer is the primary instrument for sensing sea surface salinity (SSS), while the scatterometer is included to provide a correction for sea surface roughness, which is a primary source of error in the salinity retrieval. Although the primary objective is the measurement of SSS, the instrument combination operates continuously, acquiring data over land and sea ice as well. An important feature of the data processing includes detection and mitigation of Radio Frequency Interference (RFI), which is done separately for both active and passive instruments. Correcting for RFI is particularly critical over ocean because of the high accuracy required in the brightness temperature measurements for SSS retrieval. It is also necessary for applications of the Aquarius data over land, where manmade interference is widespread, even though less accuracy is required in this case. This paper will provide an overview of the current status of the Aquarius RFI processing and an update on the ongoing work on the improvement of the RFI detection and mitigation performance.

***Index Terms*—** Microwave Remote Sensing, RFI, Aquarius

1. INTRODUCTION

For both passive and active instruments, the RFI detection is performed in the time domain and based on the signal statistics. The radiometer acquires samples every 10 ms, which is a much higher rate than required by the Nyquist-Shannon theorem, and averages all samples taken within a 1.44 second window to derive a single antenna temperature data point. The high sampling rate allows a number of samples to be discarded without significantly affecting the quality of the salinity retrieval. Samples that differs too much from the local mean are flagged as contaminated by RFI. RFI mitigation is achieved by removing the RFI-flagged samples from the processing chain before averaging them into a single data point. A more detailed description of the algorithms is given in [3].

This approach is good at detecting RFI, however it still has some limitations. First, the RFI flags only indicate suspected RFI, which may also include false RFI detection, referred to as a false alarm. This is particularly true for the radiometer measurements over land, where the samples have a higher standard deviation and are therefore more likely to exceed the RFI flagging threshold. A second issue is that strong RFI could enter the antenna sidelobes and produce the same effect as low or moderate RFI coming from the main beam. In this case, more information on the actual location of the RFI sources can be obtained by comparing RFI for ascending and descending tracks. In addition, the RFI algorithm is tuned to detect pulse RFI, for example originating from sources such as air traffic control and surveillance radars which are known sources of RFI at L-band. Finally, the operating frequency and receiver bandwidth also influences the amount of RFI affecting the system. Both the Aquarius radiometer and the Soil Moisture Ocean Salinity (SMOS) instrument operate at a center frequency of 1.413 GHz, but Aquarius has a slightly larger receiver bandwidth, 25 MHz, compared to the 20 MHz SMOS bandwidth [4]. As a results, the Aquarius radiometer is more likely to pick up spillover radio signals from systems operating in nearby frequency allocation bands.

2. STATUS AND ONGOING WORK

Aquarius was launched on June 10th, 2011, from Vanderberg Air Force Base (California), and operated continuously from August 25th, 2011, until June 7th, 2015. As reported in [5], the instrument has been rather successful in detecting and removing RFI in the data processing. Global maps of the geographical distribution of RFI have been produced for both radiometer and scatterometer and are available on the Aquarius official website for monthly periods. RFI has been found to be usually associated with large urban center and surveillance radars [6]. Significant work has been done by the SMOS mission to relate some of the radiometer RFI to known ground sources [4].

Efforts are continuing to improve the RFI detection for the radiometer. Our goal is to find an optimal balance between obtaining the highest possible data quality by minimizing the amount of false detections (i.e., the False Alarm Rate or FAR) that unnecessarily reduces the number of useful samples, and the need to remove as much RFI as possible where this is actually present.

One solution is to tune the parameters of the RFI detection algorithm to have different values depending on the geographic location. Our approach aims at studying the statistical properties of the 10-ms samples in different parts of the world, including both regions expected to be RFI-free as well as strongly contaminated areas, and find the optimal thresholds and other parameters to filter out the contamination. This can address the anomalies observed in some regions that consistently show a negative bias in the retrieved salinity and a difference between the salinity estimates for ascending and descending tracks. Not coincidentally, these areas are also relatively close to the East coast of USA and Canada, Northern Europe and China where strong RFI has been reported and may be entering the receiver through the antenna sidelobes, therefore at much lower level that is not currently detected by the RFI filter. Results in this effort to tune the algorithm parameters according to these criteria will be presented, comparing the performances using the current and the proposed implementations of the algorithm.

3. REFERENCES

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